



TechData Sheet

Naval Facilities Engineering Service Center
Port Hueneme, California 93043-4370



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Removal of Heavy Metals from Contaminated Soils at a Former Naval Air Station

A Demonstration of Electrokinetic Remediation

Conducted by: **Geokinetics International, Inc., Berkeley, California**

In coordination with: **Bay Area Defense Conversion Action Team Environmental Technology Partnership**

Introduction

The Navy conducted a pilot-scale field demonstration using Electrokinetic (EK) remediation for treating chromium-contaminated soil and groundwater at Alameda Point (formerly Naval Air Station Alameda), Alameda, California. The demonstration site is a former Aircraft Rework Facility Plating Shop. From 1942 through 1990, chromium leaked into the soil directly beneath the Shop during plating operations. Soil cores have shown chromium levels up to 2,060 mg/kg.

The demonstration project was performed in coordination with the Bay Area Defense Conversion Action Team Environmental Technology Partnership (BADCAT ETP). The BADCAT ETP is a public/private partnership of the Bay Area Economic Forum, Bay Area Regional Technology Alliance, California Environmental Protection Agency, Chevron, San Francisco State University's Center for Public Environmental Oversight, U.S. Environmental Protection Agency, U.S. Navy, and expert technological specialists working together to expedite the cleanup and conversion of closing military bases in the San Francisco Bay Area through the application of innovative environmental technologies.

Purpose of the Demonstration

The demonstration was designed to show if EK removes heavy metal contamination from alkaline soils. The primary objective of the demonstration was to reduce chromium concentrations in the soil to achieve U.S. EPA Region IX preliminary remediation goals for residential use and to develop reliable cost and performance data.

Electrokinetic Process

EK technology is applied by inserting electrode cells into the contaminated soil, and applying a direct-current electric field across the electrodes. This field causes ions, such as chromium, to move towards the electrode cells (Figure 1). Once the ion reaches the cell's electrode solution (solution surrounding the electrodes), it is readily removed from the ground for further processing and recovery.

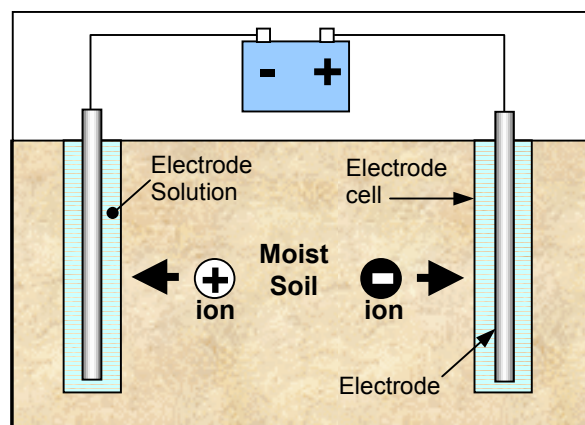


Figure 1. Electrokinetic treatment system.

Advantages of Electrokinetics

EK offers advantages over other technologies currently available for metals remediation, specifically:

- In-situ technology (soil removal not required), therefore, has much less impact on existing landscaping, buildings, or structures.
- Does not destroy the soil matrix as with acid flushing.
- Process is not limited by tight or low permeable soils, such as clay.
- Metals are actually removed from the soil unlike chemical stabilization, which leaves metals in place.

Limitations of Electrokinetics

- Alkaline soils reduce EK removal performance of metals.
- Requires soil moisture.
- If not compensated for, solid metallic contamination or service structures, such as pipelines, will impair contaminant removal.
- Open electrode well designs can be problematic when a significant drop in the water table occurs.

Field Demonstration

The demonstration project began in December 1997 and ran until its completion in June 1998. The demonstration's electrode array consisted of three rows positioned 1 meter apart, with each row incorporating five electrodes spaced every 2 meters (Figure 2). The electrodes were installed 2.4 meters below the ground surface for a total soil treatment volume of 38.4 m³. Each of the array's electrodes was housed in its own acidic solution cell (Figure 1).

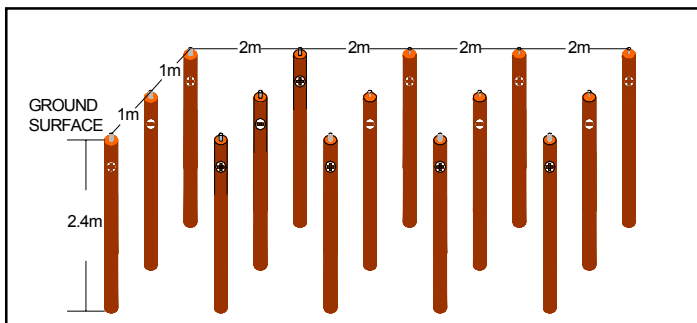


Figure 2. Site Demonstration: 3 X 5 electrode cell array.

The primary goal was the recovery of chromium (CR6+). To achieve this goal, an acidic solution was maintained at a pH between four and five for each of the array's electrode cells, which in turn increased the area's soil acidity. Once soil acidity had been increased, the chromium in the treatment area became soluble in the soil moisture and was able to more freely transport towards a nearby cell's electrode solution. Over time, chromium levels in the electrode solution increased, requiring removing the solution for processing and recovery above ground. Treatment time proceeded as planned for 4 months.

Field Demonstration Results

It is estimated that the EK treatment system removed 12 percent of the total chromium based on pre- post-treated soil data and only 1 percent based on the total chromium recovered in the electrode solution. The discrepancy between chromium removal measurements can be attributed to chromium redistribution within the subsurface as indicated by reduced chromium variation at neighboring sampling sites, as well as, the electrode cell's tendency to adsorb chromium in its bentonite seal while in route to the cell's electrode solution.

In the most contaminated layer of soil, the interface between the soil and the concrete, the EK system did not reach the project's primary goal of reducing chromium levels below EPA's Region IX preliminary remediation goal IV (PRG) of 30 mg/kg. However, the EK process did influence chromium distribution in the remaining soil layers, great enough to reduce chromium levels to below EPA's Region IX PRG.

The demonstration project encountered problems with the water table dropping below design specifications. The solution was to use bentonite membrane seals to keep the electrode solution from being depleted. Using the bentonite seals may have decreased

system performance by as much as 50 percent of the expected chromium removal rates. Therefore, because of its atypical design, the demonstration project can not be considered a good test of the technology's ability to remediate chromium from the soil.

Cost Effectiveness

The EK demonstration project was operated for 4 months at a cost of \$194,291 or \$4,318/yd³ for vendor-supplied services. The high treatment cost (\$4,318/yd³) is attributable to the demonstration's relatively short duration, requiring expensive high current density producing hardware. It was estimated that, if the site demonstration was scaled up to a full-scale system and allowed to operate for at a year, treatment costs could be reduced to \$90/yd³.

Previous Projects

Several demonstration and full-scale EK projects have been successfully conducted by Geokinetics. The full-scale projects to date were done in Europe. The results are shown in Table 1.

Table 1. Electrokinetic Projects Completed by Geokinetics*

Project	Soil Type	Volume (yd ³)	Initial Concentration (mg/kg)	Final Concentration (mg/kg)
Paint Factory	Peat/Clay	300	Cu >1,220 Pb >3,780	Cu <200 Pb <280
Galvanizing Plant	Clay	50	Zn 1,400	Zn 600
Timber Plant	Clay	250	As >260	As <30
Temporary Landfill	Sand	4,000	Cd >180	Cd <40
Military Galvanizing Plant	Clay	2,500	Cr 7,300 Ni 860 Cu 770 Zn 2,600 Pb 730 Cd 660	Cr 755 Ni 80 Cu 98 Zn 289 Pb 108 Cd 47

*Results not verified by BADCAT ETP.

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